Optical Constituents Along a River Mouth and Inlet: Variability and Signature in Remotely Sensed Reflectance, and: Optical Constituents at the Mouth of the Columbia River: Variability and Signature in Remotely Sensed Reflectance

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GOALS

The goals of these proposals are:

1. Measure the variability of optical properties in-space along a river mouth/inlet and observe the variability in time at a single position over a tidal cycle.
2. Relate this variability to the concentration and dynamics of dissolved and particulate materials, including variability in the particulate size distribution.
3. Relate the optical properties to the ocean reflectance so that algorithms to invert surface color to in-water constituents can be tested and improved.

Report Documentation Page

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APPROACH

Our approach at New River consisted of conducting physical and optical measurements from a small, fast and easy to handle vessel which could supply necessary power. In addition we deployed a satlantic HTSRB measuring upwelling radiance and irradiance and downwelling irradiance. In the Mouth of the Columbia River project we sampled from the R/V Pt Sur for five days. Reflectance was measured using a WISP radiometer.

WORK COMPLETED

New River

We conducted 5 days of sampling of which the last three days with the IOP package at the New River Inlet using two profiling packages, one containing a LISST and a camera and the other containing a CTD, an ac-9, a BB-9, a turbidity sensor, and a CDOM fluorometer (the IOP package). Additionally we deployed a radiometer buoy so that we can relate our result to hyperspectral remote sensing reflectance.

Measurements were done as follows: In days 1 and 2 samples were collected at different locations along the river. In day 3 we anchored the R/V and performed profiles ~once every half an hour at one location. In Day 4 we followed a dye patch as it was advecting with the tide. Finally in day 5 we sampled out at sea and in the Inlet to characterize the end members of the inlet (see Fig. 1 for station locations).

All the data from our package has been processed posted on our web site for distribution (http://misclab.umeoce.maine.edu/research/research24.php) and distributed to RIVET PIs. We took part in a two day RIVET workshop/meeting at Washington DC in late April 2013 where we presented the salient feature of our dataset and analysis.

Mouth of Columbia River

We carried out a suite of measurements to characterize the evolution of particle and optical properties in the Columbia River plume, moving from the mouth at Astoria, Oregon to the continental shelf just beyond the river-mouth bar. The measurements were made from the *R/V Point Sur* on June 1-5, 2013.

Two general categories of measurements were pursued. First, profiles of water-column particle and optical properties were made at the points of release of several types of Lagrangian drifters, and then the drifters were followed, with profiles of water-column particle and optical properties collected amongst the drifters and at locations of drifter recovery. Second, profiles of particle and optical properties were collected on along-river transects, extending approximately 35 km upstream from the river-mouth bar.

Measurements were made primarily with a profiling instrument package (Figure 2). The package actually comprised two packages that were bolted and hose-clamped to one another. The particle package, constructed at BIO, carried the new Machine Vision Floc Camera (MVFC), a Sequoia Scientific LISST 100x Type B, an RBR CTD, and two pressure-actuated Niskin bottles. The Niskin bottles were set to trip at 5-m and 10-m depths. The optical package carried a WetLabs ac-9 absorbance and attenuation sensor with a 10-cm pathlength, a WetLabs Eco bb2fl, that measures

backscattering at 532 and 650 nm and CDOM fluorescence, a WetLabs WetStar CDOM fluorometer, a Sequoia Scientific flow control switch, and a SeaBird 37 CTD. The flow-control switch allows the ac-9 to collect 0.2-um-filtered and raw water samples. The difference between optical properties in raw and filtered water gives calibration-independent particulate absorption and attenuation.

Water from the Niskin bottles was filtered through 8-um Millipore SWCP filters onboard the ship. On the first day, some 0.8 um filters were used. Filters were rinsed thoroughly with distilled water from the ship's system. The large filters on the ship's water system were changed midway through the cruise.

Surface samples were collected with a "glug" bottle at the end of the first cast. These samples were filtered through 8 um Millipore SCWP filters and through glass-fibre filters. The former will be used to estimate suspended particulate mass (SPM) and disaggregated inorganic grain size (DIGS) distributions. The latter will be used to calculate organic fraction, characterised by loss on ignition. Surface samples were also analyzed for turbidity with a portable Hach turbidity sensor. At the start of the cruise, one sample was characterized, but by the end samples were run in triplicate. Additionally, during the last 2 days, additional turbidity measurements, following gentle shaking, were taken, to characterize fast sinking particles.

Water leaving radiance was characterized in two ways. A WaterInSight WISP-3 was used to measure reflectance from the water surface. The WISP--3 contains three hyperspectral radiometers, measuring respectively the downwelling radiance,the upwelling radiance,and the diffuse downwelling irradiance. From the signal of these three radiometers the reflectance ('the colour') of the water can be determined. A new iPhone app developed by a UMaine student, Thomas Leeuw, at the University of Maine was also used. It measures reflectance in three broad bands, from which concentrations of in-water constituents are estimated.

The data has been processed and is now being analyzed as part of a PhD student at Dalhousie.

RESULTS

We are in the analysis phase. Preliminary results indicate strong modulation of ocean color by particulate concentration (Fig. 1) and relationships between hydrographic properties and particulate biogeochemical and optical properties (not shown).

We have been participating with PI Falk's group in an analysis of the optical remote sensing aspects of the dye release experiments at New River, a paper on which will be submitted in the coming weeks (lead author: David Clark).

IMPACT/APPLICATIONS

This proposal seeks to improve our ability to assess and predict the distribution of optical properties in the coastal region. Such information is needed to assess underwater visibility of relevance to both diving operations and underwater communication.

RELATED PROJECTS

Some instruments used in this work have been purchased through a DURIP grant (N000141010776 to E. Boss).

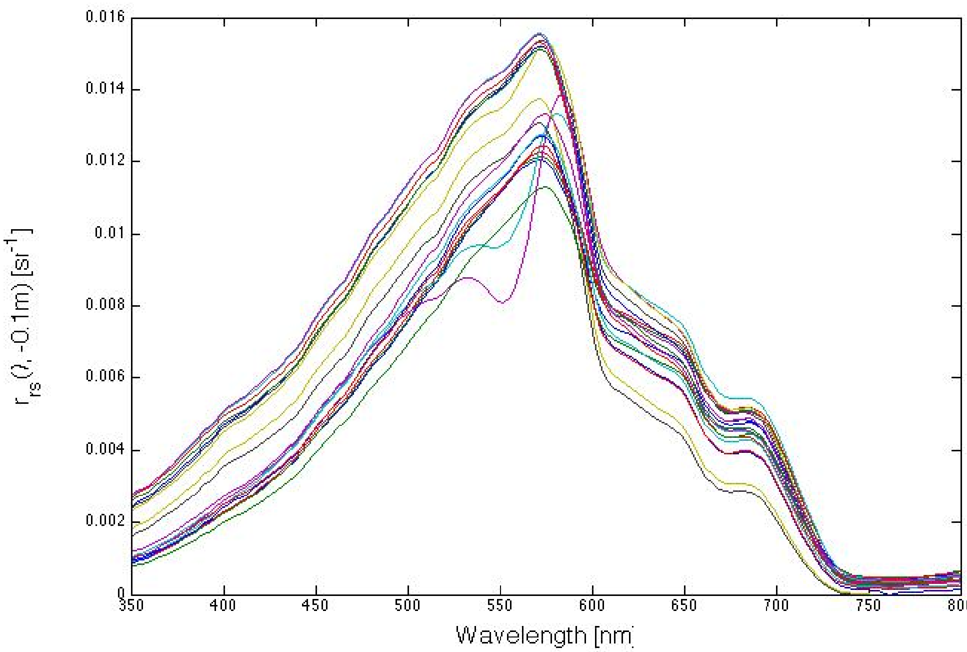

Figure 1. Modulation of remote sensing reflectance measured at a single station during a tidal cycle at New River, 5/11/2012. The spectrum with the strong decrease in reflectance near 560nm was taken during the dye-release experiment. The change in intensity at blue and red wavelengths correlates well with changes in the backscattering coefficient e.g. is due to changes in particulate concentration.

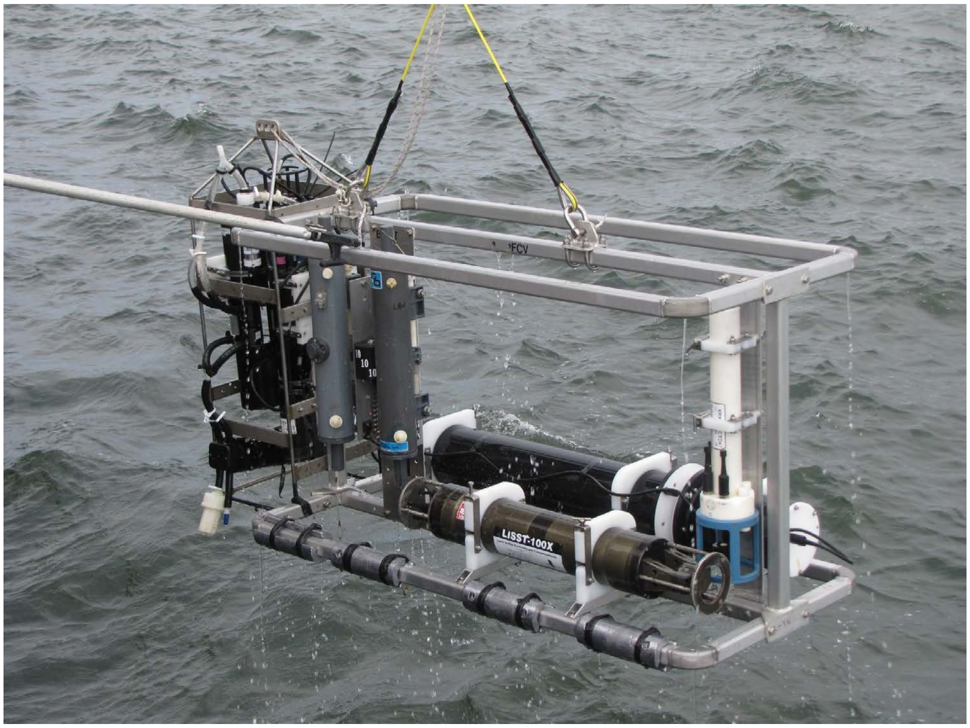

Figure 2. Particle and Optics Profiling package. On the right is an RBR CTD (vertical white cylinder), a LISST-100x type B near forward scattering and particle sizing instrument (green cylinder) and behind it the Machine Vision Floc Camera (large laying black cylinder). Two Niskin bottles designed to collect water by automatically closing at 5 and 10m are on the left (gray cylinders with white spoutes). On the left is the Optical package which is comprised of a battery, a10cm ac-9, a CDOM fluorometer a SBE-37 CTD, and an automatic switch designed to make 0.2um filtered measurements when the package is raised between 8 and 1.5m.

Figure 3. Taking a reading with the WISP-3 radiometer system designed to obtain above water remote-sensing hyperspectral reflectance.